

6/ppts

1/29

(PCT/DE00/02842)

### Description

5    Electrical Connector

The present invention relates to a device according to the generic clause of claim 1, i.e. to an electrical connector comprising a multiplicity of contact elements.

10

Electrical connectors have been known for many years in a multitude of forms.

Due to the continuous increase in complexity and efficiency of electronic systems, there are also ever increasing requirements as to the electrical connections between the system components. In this regard, there is an increasing demand of electrical connectors which on the one hand operate reliably under all circumstances, i.e. also under high mechanical and electrical loads, and which on the other hand have as many contacts as possible while being as small as possible.

There are already various electrical connectors known in  
25 which attempts have been made of fulfilling the require-  
ments mentioned.

In this context, the electrical connectors should be mentioned that are used for connecting LCD units to the apparatus controlling the same. To this end, there are usually employed electrical connectors having press-on contacts, with the press-on contacts being realized by a very dense arrangement of conductive elastomer portions in a non-conductive elastomer. The connections to be established via such electrical connectors are of rela-

tively high impedance and moreover necessitate extremely clean conditions.

40 These problems can be solved at least in part by making use of correspondingly small and multi-position connectors.

45 Multi-position connectors of miniaturized configuration are known from WO 95/24748 and WO 96/08056. However, connectors of this type are not susceptible of reliable control, both in manufacture and in handling thereof, and the same thus holds analogously for the electrical connections established by such electrical connectors.

50 It is thus the object of the present invention to provide a multi-position miniaturized connector that is capable of reliably establishing electrical connections of high quality.

55 According to the invention, this object is met by the features claimed in the characterizing part of claim 1.

60 The latter provides that the electrical connector contains one or more connector modules, each thereof comprising at least one contact support and a multiplicity of contact elements connected to said contact support and extending along the surface of the same.

65 Due to the arrangement of the contact elements along the surface of a contact support, they can be reliably arranged and held in predetermined positions without a problem. In addition thereto, when they are contacted with other contact elements, they have to be capable of withstanding no or just minimum mechanical loads. At any  
70 rate, possibly occurring mechanical loads do not entail a change of the contact element position or damage of the contact elements. This holds also for the event that

3/29

the contact elements are of weak mechanical design. The contact elements thus can be made very small and/or have a very dense arrangement.

If, for example, very narrow metal strips are used as contact elements and these are connected to the contact support supporting the same, for example, by having plastics material injection-molded thereto, which is possible without any problem with the claimed construction of the electrical connector, a multi-position miniature connector can be provided by means of which electrical connections of high quality can be reliably established.

Advantageous developments of the invention are indicated in the dependent claims, the following description and the drawing figures.

In the following, the invention will be described in more detail by way of embodiments with reference to the drawings.

In the drawings:

Fig. 1 shows a perspective view of connector modules of the electrical connectors described in more detail hereinafter,

Fig. 2 shows a frontal plan view of a connector plug containing a plurality of plug modules according to Fig. 1,

Fig. 3 shows a frontal plan view of a connector coupling member containing a plurality of coupling modules according to Fig. 1,

Fig. 4A shows a cross-sectional view of the plug according to Fig. 2,

Fig. 4B shows a cross-sectional view of the coupling member according to Fig. 3,

Fig. 4C shows a cross-sectional view of an assembly in which a plug according to Fig. 2 and a coupling member according to Fig. 3 are mated,

Fig. 5 shows a bottom plan view of a base of the plug according to Fig. 2 or of the coupling member according to Fig. 3, said base being mountable on a circuit board by way of the BGA technology, and

Fig. 6 shows a bottom plan view of a modified base of the plug according to Fig. 2 or of the coupling member according to Fig. 3.

The electrical connectors described hereinafter are circuit board connectors. However, it is to be pointed out already here that there is no restriction thereto. The special features of the electrical connectors described may also be applied to electrical connectors employed for other purposes.

As is usual with pluggable connectors, an electrical connection is established by mating an electrical connector in the form of a plug and an electrical connector in the form of a coupling member.

In the embodiment illustrated, the plug comprises a multiplicity of identical plug modules arranged side by side and/or on top of each other. The same holds for the coupling member. The latter comprises a multiplicity of identical coupling modules arranged side by side and/or

5/29

on top of each other. However, the invention is not restricted to this. The plug and the coupling member may also contain only one module or a plurality of not identical modules.

150

A plug module and a coupling module are shown in a perspective view in Fig. 1. The plug module is designated SM and the coupling module is designated KM. The plug module SM is adapted to be inserted into the coupling module KM.

155

In the embodiment illustrated, each connector module (each plug module and each coupling module) comprises 32 contact elements. However, the number of contact elements may also be arbitrarily higher or lower.

160

If a plurality of such plug modules SM is arranged above each other and/or beside each other on a base that is preferably common to all plug modules and if these are enclosed by a common housing, one arrives at the electrical plug described in more detail herein. The front view of such an electrical connector is shown in Fig. 2.

165

The same holds for the coupling modules KM in corresponding manner. If a plurality of such coupling modules KM is arranged on top of each other and/or side by side on a base that is preferably common to all coupling modules and if these are enclosed by a common housing, one arrives at the electrical coupling member described in more detail herein. The front view of such an electrical connector is shown in Fig. 3.

170

175

Figs. 4A, 4B and 4C illustrate cross-sectional views of the electrical connectors according to Figs. 2 and 3. To be precise, Fig. 4A shows a cross-sectional view of the plug according to Fig. 2, Fig. 4B shows a cross-sectional view of the coupling member according to Fig. 3,

180

6/29

and Fig. 4C shows the plug according to Fig. 2 and the coupling member according to Fig. 3 in the mated state.

185

The plug illustrated in Fig. 4A comprises a base 1 (already mentioned hereinbefore), a housing 2 (also already mentioned) and one or more plug modules SM, with each plug module SM consisting of a contact support 3 and a multiplicity of contact elements 4.

190

In the embodiment shown, there is provided one single contact support 3 for each plug module SM; each contact support 3 has mounted thereon all contact elements of the respective plug modules. However, the invention is not restricted to this design. Basically, there may be an arbitrary number of contact supports provided for each plug module SM.

195

As can be seen in particular from Figs. 1 and 2, the contact elements 4 are arranged on the contact support 3 carrying the same in the form of two mutually opposing contact element rows. Although this is presently deemed to be the optimum arrangement, the invention is not restricted thereto.

200

205

In the embodiment shown, the contact elements 4 are constituted by relatively long and relatively narrow metal strips with as high rigidity as possible. In a portion 41 located relatively far to the rear, they have a (preferably multiply) curved or kinked path (e.g. of zig-zag shape). The contact elements 4 of the plug and/or of the coupling member in addition thereto have in the front portion (the portion provided for establishing contact with the contact elements of the coupling member and the plug, respectively) at least one, but preferably two or more bulges or equivalent designs of the contact elements. In the embodiment shown, it is the contact elements 4 of the plug that are provided

210

215

220 with these bulges; these bulges bear the reference numeral 42.

The bent or kinked portion 41 of the contact elements 4 renders possible that the parts of the contact elements  
225 located on either side, i.e. both sides of said portion are movable relative to each other. In the properly assembled condition of the electrical connector, portion 41 comes to lie in a cavity 11 of the electrical connector present between base 1 and contact support 3, and  
230 thus renders possible that the location of the contact element, and more strictly speaking the location of the plug modules containing the same may still vary and/or be changed to a certain extent with respect to the proper normal position also in the assembled state of  
235 the plug, both in the longitudinal direction of the contact elements 4 and in the direction transverse to said longitudinal direction. This turns out to be advantageous both in terms of manufacture of the electrical connector and in terms of use thereof.

240 The bulges 42 (or comparable designs of the contact elements) constitute resilient contact locations via which the contact elements 4 of the plug are contacted with the contact elements of the coupling member. If, as in  
245 the embodiment shown, there are provided several contact location establishing bulges or the like on each contact element, the respective contact elements may be contacted at multiple locations with the contact elements to be contacted, and thus are multiple contact elements  
250 permitting particularly good and reliable connections to be established with other contact elements.

The contact elements 4 are each arranged so as to extend along the surface of the contact supports 3 carrying  
255 them and are held in the proper position on the respec-

8/29

tive contact support 3 by having plastics material injection-molded around part thereof.

260 In case of the plug, the contact supports 3 are constituted by rails provided with groove-like recesses 31 at those locations where the contact elements 4 are supposed to come to lie, i.e. on mutually opposing longitudinal sides.

265 In assembling the contact elements 4 on the contact supports 3, the contact elements 4 are inserted into the groove-like recesses 31 and then are fixed to the respective contact support by injection-molding around the rear end of the contact support 3 and the contact element parts located there.

270 The contact elements 4 then are mounted to the contact support 3 such that the front end thereof terminates a distance before the front end of contact support 3 and that the rear end thereof, inclusive of the bent or kinked portion 41, projects beyond the rear end of contact support 3.

280 In the embodiment shown, the portions without injection-molding of the parts of the contact elements arranged in the groove-like recesses 31 of contact support 3 are not attached to the contact support 3. However, the contact elements are designed and injection-molded to the contact supports such that the non-molded portions thereof extending through the groove-like recesses 31 are resiliently urged against the bottom of the recess 31 through which they extend. It is ensured in this manner that the contact elements - although these are each attached to the contact supports at one single location only - cannot or, at any rate, cannot easily leave the groove-like recesses.

9/29

By way of the design and assembly of the contact elements as described hereinbefore, these can be reliably  
295 held in their proper position even if they are of very small and/or weak design and/or if they were subjected to mechanical loads.

Due to the afore-mentioned injection molding operation  
300 around contact support 3, the latter is provided with a collar 32 at the rear end thereof. This collar, as will still be described in more detail, can be utilized for mounting the contact supports (the plug modules containing the contact supports) within the plug. By way of the  
305 afore-described connection of contact support and contact elements, the plug module thus does not become larger than without such a connection.

As regards the contact support 3, it is to be noted furthermore that the same is tapered at the front end  
310 thereof (where no contact elements are provided). This serves for centering the mutually associated plug and coupling modules during mating of plug and coupling member.

315 A contact support 3 and the contact elements arranged thereon as just described constitute a plug module SM of the type shown in Fig. 1.

320 A plurality of the plug modules SM that can be configured and made as described hereinbefore can be combined with the afore-mentioned base 1 and the afore-mentioned housing 2 so as to form a plug of the type according to Fig. 2.

325 In the embodiment shown, the base 1 is a plate-like member designed at the top thereof for placement of a plurality of plug modules SM and of the housing 2, and designed at the bottom thereof for soldering the rear ends

10/29

330 of the contact elements 4 to the base 1 and for mounting  
the base 1 on a circuit board, not shown in the draw-  
ings. The base 1 is formed in its bottom with a multi-  
plicity of holes provided for passage of the rear ends  
of the contact elements 4. The top side of the base bot-  
335 tom is provided in addition with the recesses which, in  
the assembled state of the plug, constitute the already  
mentioned cavities 11. In assembling the plug modules SM  
on the base 1, the rear ends of the contact elements 4  
are passed through the holes in the base bottom and are  
340 soldered or otherwise electrically and/or mechanically  
connected to the base on the bottom side thereof or to  
elements provided for connecting the base to the circuit  
board. The bent or kinked portions 41 of the contact  
elements 4 come to lie in the recesses of base 1 that  
345 constitute the cavities 11 of the plug.

In the embodiment illustrated, the housing 2 is a  
trough-like structure having a bottom 21 and side walls  
22. Bottom 21 is provided with openings through which  
350 the forward parts of the plug modules SM can be passed.  
The rear ends of the plug modules SM, which carry the  
collars 32, cannot pass the openings in the housing bot-  
tom. In the assembled state of the plug, the plug module  
parts not fitting through the housing bottom openings  
355 come to lie between the housing 2 and the base 1, as  
shown in exemplary manner in Fig. 4A. Housing 2 is con-  
nected to base 1, for example, by an adhesive bond, a  
locking-type connection or other connection. Thus, base  
1, housing 2 and plug modules SM thus are combined to  
360 form an integral unit.

In the assembled state of the plug, as described, the  
side walls 22 of housing 2 extend around the portion of  
the plug containing the plug modules. These walls proj-  
365 ect beyond the front ends of the plug modules.

11/29

The front end of the housing side walls 22 is provided with a taper 23 on the inside thereof. This taper serves for centering plug housing and coupling member housing when plug and coupling member are mated.

In the embodiment illustrated, the coupling member for connection to the plug designed and made as described hereinbefore, is of different construction and manufactured differently than the plug.

As can be seen in particular from Fig. 4B, the coupling member comprises a base 6, a housing 7 and a plurality of coupling modules KM, with each coupling module KM consisting of a contact support 8 and a multiplicity of contact elements 9.

In the embodiment illustrated, there is provided for each coupling module KM one single contact support 8 each; each thereof has mounted thereon all contact elements 9 of the respective coupling modules. However, the invention is not restricted to this design. Basically, it is possible for each coupling module KM to have an arbitrary number of contact supports 8.

As can be seen in particular from Figs. 1 and 3, the contact elements 9 are arranged on their supporting contact support 8 in two mutually opposing contact element rows. Although this is presently deemed to be the optimum arrangement, the invention is not restricted thereto.

In so far, there is conformity with the plug according to Fig. 4A. The individual components of the coupling member, however, are different from the corresponding components of the plug.

12/29

In the embodiment illustrated, the contact elements 9, just like the contact elements 4 of the plug, are constituted by relatively long and relatively narrow metal strips with as high rigidity as possible. In a portion 91 located relatively far to the rear, they have a (preferably multiply) curved or kinked path (e.g. of zig-zag shape), but are otherwise of straight design.

The bent or kinked portion 91 of the contact elements 9 renders possible that the parts of the contact elements 9 located on either side thereof are movable relative to each other. In the properly assembled condition of the electrical connector, portion 91 comes to lie in a cavity 61 of the electrical connector present between base 6 and contact support 8, and thus renders possible that the location of the contact elements 9, and more strictly speaking the location of the coupling modules containing the same may still vary and/or be changed to a certain extent with respect to the proper normal position also in the mated state of the coupling member, both in the longitudinal direction of the contact elements and in the direction transverse to said longitudinal direction. This turns out to be advantageous both in terms of manufacture of the electrical connector and in terms of use thereof.

The contact elements 9 are each arranged so as to extend along the surface of the contact supports 8 carrying the same. In this case, however, the contact support 8 is injection-molded to the contact elements which prior thereto were properly arranged and aligned (and inserted in an injection-molding means). Injection-molding of the contact support 8 to the contact elements 9 means for the contact elements 9 a partial injection-molding of plastics material around the same. Due to this molding operation, the contact elements are attached to the contact support 8 formed by such injection-molding, with

13/29

440 such attachment being effected over the entire length of the contact element portions extending along the contact support 8.

445 In the embodiment illustrated, the contact supports 8 are constituted by sleeves of rectangular cross-section which on two confronting insides are provided with a row of contact elements 9 each and at the rear end thereof have a collar 82 extending around the contact support 8.

450 The contact elements 9 are arranged on the contact support 8 such that the front end thereof terminates a distance before the front end of the contact support 8 and that the rear end thereof, inclusive of the bent or kinked portion 81 projects beyond the rear end of the  
455 contact support 8.

The part of the contact elements extending along the surface of contact support 8, in the embodiment illustrated, is connected to the contact support 8 along the  
460 entire length thereof. The contact elements 9 thus can be reliably held in their proper position, even if they are of very small and/or weak design and even if they were subjected to mechanical loads.

465 A contact support 8 and the contact elements 9 arranged thereon as just described constitute a coupling module KM of the type shown in Fig. 1.

470 The contact support 8 is tapered on the inside edge on its front end (where no contact elements are provided). This serves for centering the mutually associated plug and coupling modules when plug and coupling member are mated.

475 A plurality of the coupling modules KM that can be configured and made as described hereinbefore can be com-

14/29

bined with the afore-mentioned base 6 and the afore-mentioned housing 7 so as to form a coupling member of the type according to Fig. 3.

480

In the example shown, the base 6 is a plate-like member designed at the top thereof for placement of a plurality of coupling modules KM and of the housing 2, and designed at the bottom thereof for soldering the rear ends of the contact elements 9 to the base 6 and for mounting the base 6 on a circuit board, not shown in the drawings. The base 6 is formed in its bottom with a multiplicity of holes provided for passage of the rear ends of the contact elements 9. The top side of the base bottom is provided in addition with the recesses which, in the assembled state of the coupling member, constitute the already mentioned cavities 61. In assembling the coupling modules KM on the base 6, the rear ends of the contact elements 9 are passed through the holes in the base bottom and are soldered or otherwise electrically and/or mechanically connected to the base on the bottom side thereof or to elements provided for connecting the base to the circuit board. The bent or kinked portions 91 of the contact elements 9 thus come to lie in the recesses of the base that constitute the cavities 61 of the coupling member.

490

485

495

500

505

510

In the embodiment illustrated, the housing 7 is a profiled member of rectangular cross-section that is open at the top and at the bottom and has an inner portion subdivided by intermediate walls 72 extending parallel to the outer walls 71. By way of the outer and intermediate walls 71 and 72, a multiplicity of channels is defined that are arranged side by side and on top of each other, with each channel being adapted to receive a coupling module. The outer and ~~intermediate~~ <sup>intermediate</sup> ~~lateral~~ walls 71, 72 of housing 7 extend around each individual coupling module

15/29

when the coupling modules are in the state attached to the base and the ~~coupling modules~~ housing.

515

The outer and ~~lateral walls~~ <sup>intermediate</sup> 71 and 72 have projections 711 and 721 which project into the channels and, in the assembled state of the coupling member, come to lie shortly above the collars 82 of the coupling modules KM; 520 the collars 82 of the coupling modules, in the assembled state of the coupling member, come to lie between base 6 and housing 7, as shown in exemplary manner in Fig. 4B.

525

The housing 7 is connected to the base 6, for example, by an adhesive bond, a locking-type connection or other connection. Base 6, housing 7 and coupling modules KM thus are combined to form an integral unit.

530

In the assembled state of the coupling member, as described, the walls 71 and 72 of housing 7 extend around each individual one of the coupling modules of the coupling member. The housing parts (walls 71, 72) enclosing the coupling modules project beyond the front ends of the coupling modules.

535

The front end of outer walls 71 of housing 7 are provided with a taper 712 on the outsides thereof. This taper serves to center plug housing and coupling housing when plug and coupling member are being mated.

540

545

Upon mating of plug and coupling member, the front ends of housings 2 and 7 meet first, since at least one of the housings, but preferably both housings, extend beyond the front ends of plug and/or coupling modules. Due to the tapers 23 and 712 provided at the front ends of the housings, the housings are centered relative to each other and may thus easily be slid onto each other. In the embodiment illustrated, the plug housing is slid

16/29

over the coupling housing. When the housings 2 and 7  
550 meet, the plug modules and the coupling modules still  
are a distance apart from each other. Sliding of the  
housings 2 and 7 onto each other thus may effect pre-  
centering of the same - without any forces acting on the  
plug modules and the coupling modules.

555

While the plug housing is being slid onto the coupling  
housing, the associated plug and coupling modules sooner  
or later meet. As these are tapered on their front ends  
as well and since, moreover, they are already pre-cen-  
560 tered, they can be inserted into each other substan-  
tially without any mechanical loads being exerted  
thereon.

In the embodiment illustrated, this is enhanced further  
565 by the fact that the plug modules and/or the coupling  
modules are movable relative to each other and/or rela-  
tive to the respective housings and/or bases.

With regard to the plug modules, this movability is  
570 achieved in that

- the plug modules are attached to the plug "only" in  
that a predetermined part of the plug modules (the  
collar 32 in the embodiment illustrated) is held more  
575 or less loosely between base 1 and housing 2 (between  
collar 32 and the parts of base 1 and housing 2 sur-  
rounding the same, there are provided spaces permit-  
ting movements of the respective plug module to a  
certain extent in the assembled state of the plug as  
580 well), and

- the contact elements 4 have a bent or kinked portion  
(portion 41) which comes to lie in a cavity (cavity  
11) provided between base 1 and housing 2 and thus to  
585 a certain extent permits relative movements of the

17/29

contact element parts located on either side of portion 41 in the assembled state of the plug as well.

590 The plug modules thus can at least slightly move relative to each other and/or relative to the other plug components.

With respect to the coupling modules that are movable in this manner as well, the movability is achieved in that

595 - the coupling modules are attached to the coupling member "only" in that a predetermined part of the coupling modules (the collar 82 in the embodiment illustrated) is held more or less loosely between base 600 61 and housing 72 (between collar 82 and the parts of base 6 and housing 7 surrounding the same, there are provided spaces permitting movements of the respective coupling module to a certain extent in the assembled state of the plug as well), and

605 - the contact elements 9 have a bent or kinked portion (portion 91) which comes to lie in a cavity (cavity 61) provided between base 6 and housing 7 and thus to a certain extent permits relative movements of the 610 contact element parts located on either side of portion 91 in the assembled state of the coupling member as well.

615 The coupling modules thus can at least slightly move relative to each other and/or relative to the other coupling member components.

620 Due to the mutually independent floating arrangement of the plug modules SM within the plug and the mutually independent floating arrangement of the coupling modules KM in the coupling member, the plug modules and the cou-

18/29

pling modules can align optimally with respect to each other in all situations, whereby they can at all times be properly mated automatically and without or at any rate without significant mechanical loads being exerted on the modules and the connectors containing the same. This holds even if the components of the plugs and coupling members are not manufactured and/or assembled exactly according to specifications and/or if their positions and/or their dimensions vary (e.g. due to slight damages or temperature fluctuations).

In mating plug and coupling member, each plug contact element 4 establishes contact with the associated coupling member contact element 9 at multiple locations. It is thus possible to establish electrical connections of highest quality.

The coupling member contact elements 9, during mating with the plug contact elements 4, come to lie in the groove-like recesses 31 of the plug modules; the webs of the contact support 3 of the plug, which are present between adjacent groove-like recesses 31, in the mated state of plug and coupling member, extend up to the contact supports 8 of the coupling member and thus separate (isolate) adjacent contact element pairs from each other. Adjacent contact elements of the plug and coupling modules thus cannot interfere with each other. In particular, no flow of leakage currents is possible.

Plugs and coupling members with constructions as described can be mated and unmated substantially without a risk of damage and, in doing so, permit excellent electrical connections to be established in all situations. The connections are of low impedance, withstand high voltages and large currents and are relatively insensitive to fluctuating or adverse effects from the sur-

19/29

roundings, such as extreme and/or fluctuating temperatures, vibrations, moisture, dirt etc.

660

The properties mentioned are obtained irrespective of the size and contact density of the electrical connectors designed and manufactured as described hereinbefore.

665

The electrical connectors described thus can be made very small and/or with high contact density with in essence the same excellent properties.

670

This was confirmed by tests: to this end, the electrical connectors shown in Figs. 2 and 8, i.e. electrical connectors each with 8 connector modules and in total 256 contacts were realized on a space of 24.9 mm x 5.4 mm x 9 mm (length x width x depth in the mated state).

675

The handling properties of the electrical connectors and the quality of the electrical connections that can be produced by them turned out to be excellent.

680

Some technical data:

Range of operating temperatures:

-30 to +125°C

685

Current-carrying capacity per contact:

250 mA at 25°C

150 mA at 85°C

Breakdown strength of adjacent contacts:

690

650 V with dc current

750 V with ac current

Volume resistivity:

175 mΩ

20/29

695

Contact resistance:

40 m $\Omega$

Insulation resistance:

700

4 x 10<sup>10</sup>  $\Omega$

These are results that cannot even approximately be achieved using known multi-position miniature connectors.

705

For connecting the electrical connectors to the circuit board carrying them, it is to be pointed out that the electrical connectors, to be more precise the bases thereof, can be mounted on circuit boards using, for example, the so-called BGA (ball grid array) or PSGA (plastic stud grid array) technology.

710

With regard to BGA technology, it is to be pointed out that the balls may be arranged directly at the locations where the contact element parts passed through the base reach the bottom side of the base, or may be arranged more or less remote therefrom.

720

In the latter case, i.e. if the balls are arranged more or less remote from the locations where the contact element parts passed through the base reach the bottom side of the base, the contact elements or the locations where these reach the bottom side of the base, respectively, and the balls must be electrically connected to each other via conductive tracks or in a different manner. This is illustrated in Fig. 5 in exemplary manner. The locations where the contact elements reach the bottom side of the base are designated 15, the balls are designated 16 and the conductive tracks connecting the locations 15 to the balls 16 are designated 17.

730

If the balls are arranged directly at the locations where the contact elements reach the bottom side of the base, these locations are preferably positioned such that they (and the balls to be applied thereto) are spaced apart by certain minimum distances. The locations where the contact elements reach the base bottom side then are no longer arranged in two opposing rows, as in case of the contact elements on the contact supports, but are arranged, for example, in two opposing double rows each consisting of two individual rows arranged in mutually offset manner (in the embodiment illustrated, by half of the distance between adjacent elements of the row). Such an arrangement is shown in Fig. 6. The locations where the contact elements reach the base bottom side are again designated 15, and the balls are again designated 16. The balls 16 lie on the locations 15 so that, contrary to the base according to Fig. 5, there are no longer required conductive tracks for connecting the same.

Due to the measures mentioned, it is possible in both cases, i.e. both if the balls are arranged directly at the locations where the contact element parts passed through the base reach the base bottom side, and if the balls are more or less remote from these locations, to ensure in all situations (in particular irrespective of the contact element density of the respective connector modules) that the balls are spaced apart from each other to the extent necessary for practical application of the BGA technology.

Irrespective of this, plugs and coupling members of the type described hereinbefore may also be realized with leading or trailing contacts, double contacts and power contacts.

22/29

Electrical connectors having a construction as described  
may be designed as multi-position miniature connectors  
770 by means of which electrical connections of high quality  
can be established in reliable manner.